NEVO+ 600 series User Manual

The NEVO+ series user manual has been prepared by the Vox Power design team to assist qualified engineers in correctly implementing the product and to achieve the best reliability and performance.

NEVO+ series overview

The NEVO+600 switch mode power supply series offers truly unrivalled power density, providing 600 W at 25 W/in^3 in a 5” x 3”x 1U package. It is the ultimate power solution for system designers as they address the pressing demands for more power within less space. Providing multiple isolated outputs, the series carry full UL60601 (NEVO+600M only) and UL60950 (NEVO+600S only) safety approvals.

The basic system consists of an input module together with up to four fully isolated output modules. Single output modules have advanced remote voltage and current programming functionality as standard. While dual output modules allow for up to eight fully isolated outputs.

The input module delivers up to 600 W of output power and has 4 slots, each capable of separately delivering up to 150 W. A 5 V, 200 mA medically isolated bias supply together with an AC_OK signal and a global inhibit signal that can disable all outputs simultaneously, comes as standard on all models.

Output modules are available in a range of output voltages to suit all applications.

Single output modules with voltage ranges from 1.5V to 60V, currents up to 25A and paralleling and series capability can result in a voltage range up to 240V and a maximum current of up to 100 Amps from a single Nevo+600 configuration.

Dual output modules have a voltage ranges from 1.5V to 15V and currents up to 5A with series capability.

By selecting the correct output modules, a custom power solution can be configured in a few minutes. This instantly available custom solution offers industry leading power density, total system efficiencies of up to 89% and suits all types of applications including industrial, medical, aerospace, military and telecoms.

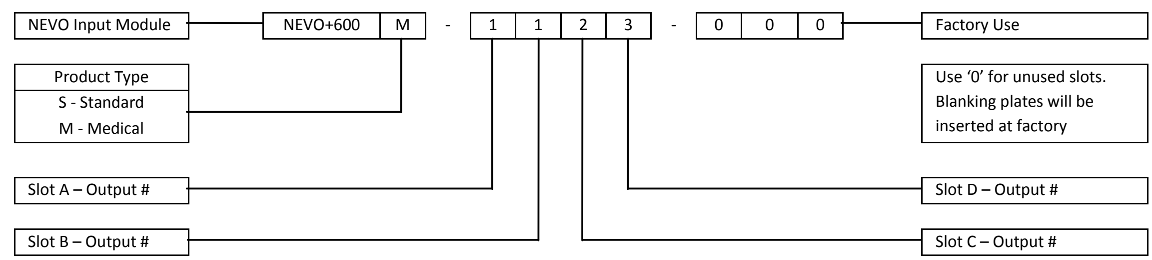
Contents

Part numbers and ordering information

INPUT MODULES	
Model	**Details**
NEVO+600S	600 Watt input stage with standard leakage current.
NEVO+600M	600 Watt input stage with medical leakage current and isolation requirements.

OUTPUT MODULES							
Model	**Nominal voltage**	**Rated current**	**Rated Power**	**Adjustment range**	**Load regulation**	**Line regulation**	**OVP**
0	Unused slots						
1	5V	25A	125W	1.5V-7.5V	±50mV	±0.1%Vnom	9V
2	12V	15A	150W	3V-15V	±100mV	±0.1%Vnom	18V
3	24V	7.5A	150W	9V-30V	±150mV	±0.1%Vnom	36V
4	48V	3.75A	150W	18V-58V	±300mV	±0.1%Vnom	66V
5	12V Dual	5A	75W x 2	5V-15V Each Ch	±50mV	±0.1%Vnom	20V
6	3.3V Dual	5A	25W x 2	1.8V-5V Each Ch	±50mV	±0.1%Vnom	8V
7	12V/3.3V Dual	5A	75W/25W	5V-15V/1.8V-5V	±50mV	±0.1%Vnom	20V/8V

PART NUMBERING SYSTEM



When initially ordering non-nominal voltage settings add " /Voltage" after each output # where a special voltage setting is required
E.g. If 3.30Vdc is required in slot B and all other slots require nominal voltages then use:

NEVO+600M – 1 – 1/3.30 – 2 - 3

The factory will then issue a 3 digit code for your specific configuration that can be used for all future orders of the same configuration
When ordering an input unit with no outputs inserted, simply order NEVO+600M or NEVO+600S

Installation Notes

This power supply is intended for use within equipment or enclosures which restricts access to authorised personnel only. The instructions in this manual and all warning labels on the product must be followed carefully.

Safety
All power supplies must be installed correctly in a controlled environment which restricts access to any unauthorised personnel. Equipment and system manufacturers must protect service personnel against unintentional contact with the output terminals.

Hazards
If series and/or parallel combinations of outputs exceed safe voltage and/or energy levels, the final equipment manufacturer must provide appropriate protection for both users and service personnel.

Health and safety
To comply with section 6 of the health and safety at work act, a label that is clearly visible to service personnel must be placed on the final equipment, which warns that surfaces of the power supply may be hot and should not be touched when the product is operating.

Fusing
The power supply has internal single pole fusing in the L (Live) line.

Servicing
The power supply contains no user serviceable parts. Repairs must be carried out by authorised personnel only. Contact Vox Power Ltd for further information.

Cooling
For proper cooling of the power supply, the air intake and outlet must not be impeded. Allow 50 mm clearance at both ends and position cabling appropriately. Avoid excessive back pressure in the general system or when using ducting to navigate hot air out of the system.

Earth terminal marking
To comply with the requirements of UL60950-1, EN60950-1, IEC60950-1, CSA22.2 no. 60950-1, UL60601-1, EN60601-1, EN61010-1, IEC60601-1, IEC61010-1, CSA22.2 no 601-1 where the incoming wiring earth is intended for connection as the main protective earthing conductor and where the terminals for such a connection is not supplied on a component or subassembly such as a terminal block, the user shall add an appropriate label displaying a protective earth symbol in accordance with 60417-2-IEC-5019 directly adjacent to the terminal. The label should be durable and legible and should withstand the 15s rub test as per UL60950-1 section 1.7.15.

Mounting
The unit can be mounted using the bottom or side mounting points. Each mounting point accepts an M4 screw where the maximum penetration, inclusive of 1.75 mm chassis thickness, should never exceed 4.00 mm. The maximum torque for the M4 screws is 1.50 Nm.

Other

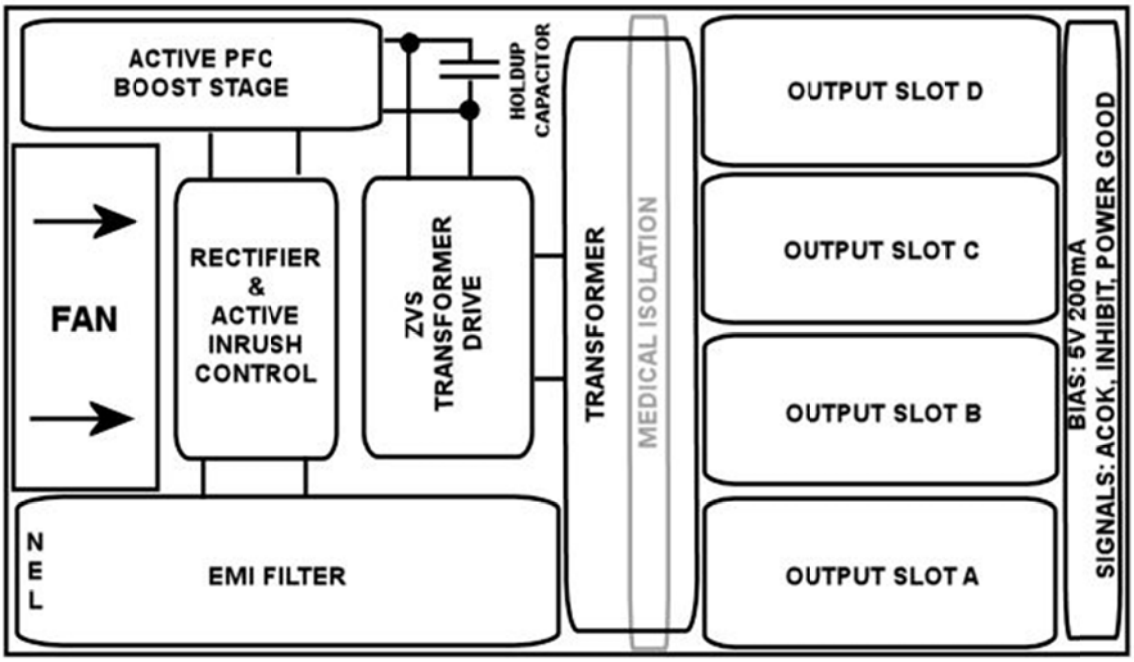
- To prolong the life of the unit, use in a dust free environment.
- If units are damaged during transit, contact your sales agent or Vox Power and DO NOT apply power to the unit.
- Always use adequately sized cables and ensure good crimp connections.
- Use cable supports to minimise stress on connectors.
- Avoid excessive shock or vibration.

General installation parameters

- Equipment class I
- Installation category II
- Pollution degree 2
- Material group IIIb (Indoor use only)
- Flammability rating 94V-2
- IP rating IP10
- RoHS compliance 2002/95/EC

Theory of operation

The diagram below outlines the topology and major internal components of a fully assembled system. Four output slots are provided and can be populated by any combination of *output modules*. The remaining components in the block diagram are housed in the *input module*.



The *input module* is responsible for receiving the AC mains line voltage and converting it to an appropriate DC voltage whilst providing protection from AC line disturbances and preventing excessive EMI emissions and current harmonics. The integrated EMI filter attenuates high frequency current emissions to levels below EN55022 class B. It also provides single pole fusing in the live conductor and protection from line disturbances as outlined in EN61000.

Inrush current is controlled by a resistive element upon initial connection to the AC line. Once the internal capacitances have been charged, the resistive element is bypassed to reduce losses.

Active Power Factor Correction (PFC) is used to ensure an accurate input current waveform with extremely low harmonic content, exceeding the requirements of EN61000. This stage also provides active input current limiting which prevents overloading of the input stage while maintaining high power factor.

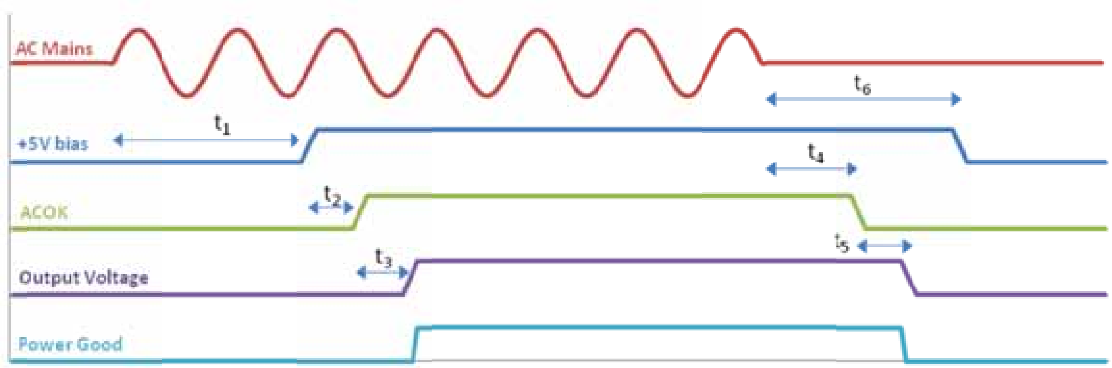
The output of the PFC stage charges the hold-up electrolytic capacitors which store enough energy to allow the system to continue operating during minor line disturbances. These are the only electrolytic capacitors in the entire power supply and to further increase system reliability, long life and high temperature capacitors are used.

A highly efficient zero voltage switching circuit is used to drive the medically isolated transformer from the hold-up capacitors. The output modules connect to the transformer secondary and provide safe isolated power to a high performance synchronous rectifier power converter which is controlled using the latest analog control technology to produce superior output performance in an extremely reduced size.

Input module operation

Startup & shut down

The NEVO+ input modules operate from a universal input voltage range and start automatically upon application of adequate AC mains voltage (>84Vrms). After a short delay, the global 5V bias supply starts and the ACOK signal goes high to indicate that the mains voltage is present and input stage is operating correctly. Once the ACOK signal is high, the output modules turn on and deliver power to the application loads. The power good signals will indicate that the output voltages are within specification. The diagram below shows the normal start up/shut down sequence and gives typical timings.



Typical timing values: t_1 φ 300 ms, t_2 φ 50 ms, t_3 φ 25 ms, t_4 φ 15 ms, t_5 = 5 ms (minimum), t_6 φ 100 ms

When the AC mains voltage is removed, the internal hold-up capacitors will supply power to the load for typically 20 ms (t_4+t_5) at maximum power. The ACOK signal will go low at least 5ms before the output voltages fall below the power good threshold level. This allows the application to prepare for the impending loss of power. The 5V bias supply will remain on for typically 100ms, after the output modules have turned off.

Hold-up

For short line distubances (<20ms), the output voltages will not be affected*. However, the ACOK signal may still go low to warn that there is an impending loss of output power. The ACOK signal will return to the high state once the unit has recovered from the disturbance.

*Outputs that are adjusted above the hold-up voltage as detailed in their respective datasheets, may experience a dip in voltage but never below the hold-up voltage specified.

Idle power

The idle power of the NEVO+ PSU is extremely low when compared to similar power supplies.

With the output modules enabled the unit typically only requires 28 W with no output load. To reduce the idle power further the outputs can be disabled using the global inhibit (GINH) pin. With the outputs disabled the unit typically requires less than 21 W.

Over temperature Protection (OTP)

The input module is protected from excessive temperatures by means of various internal sensors. If temperature thresholds are exceeded the entire unit may latch off, with no ACOK warning. To re-enable the unit the AC mains must be disconnected for approximately 2 minutes.

Power derating

NEVO+600 units must always be operated within its stated operating limits. Equipment manufacturers and other users must take appropriate deratings into account at all times when specifying a unit for the intended application. If in doubt contact your sales representative or Vox Power for assistance.

There are two main deratings for NEVO+ power supplies, temperature and input line voltage. Temperature deratings apply to both input and output modules, while line deratings apply only to the input module.

For temperature, the derating for both input and output modules is 2.5% (of maximum rated power) per degree Celsius above 50°C. While, for input line voltage, the derating for the input module only is 0.7143% (of maximum rated power) per volt below 120Vrms. These deratings can be calculated using the following conditional equations;

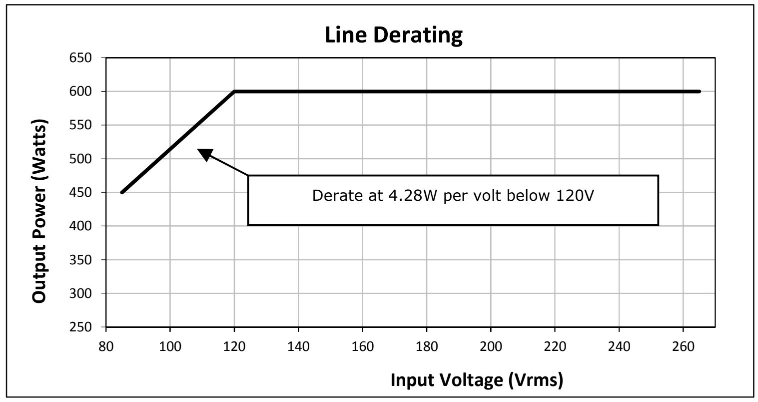
Equation for line derating:

If Vin < 120,

Pout = Prated*Line derating factor
= Prated*(1-(0.007143*(120-Vin))

Otherwise,

Pout = Prated



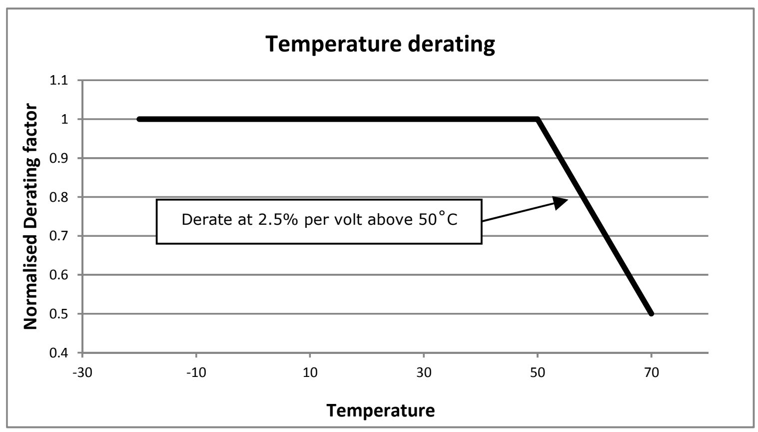
Equation for temp derating:

If temp > 50C,

Pout = Prated*Temp derating factor
= Prated*(1-(Temp-50)*0.025)

Otherwise,

Pout = Prated



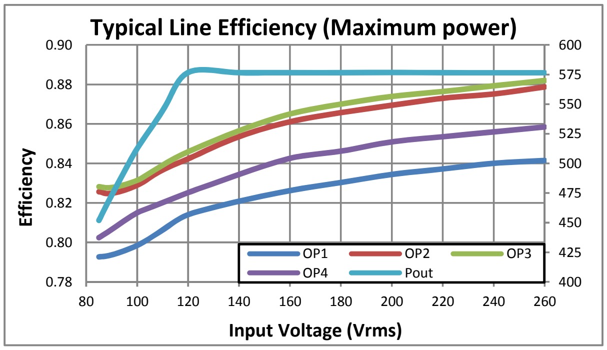
Depending on the application conditions, one or both of the deratings may apply. Where both apply, the derating factors given above can be multiplied together to obtain the total derating factor.

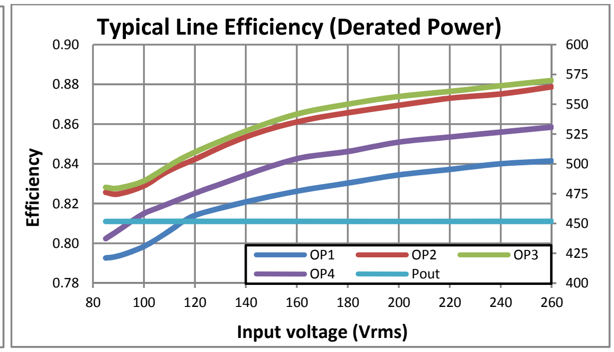
Example: What are the NEVO+600 input and output module deratings at 60°C at 100V line?

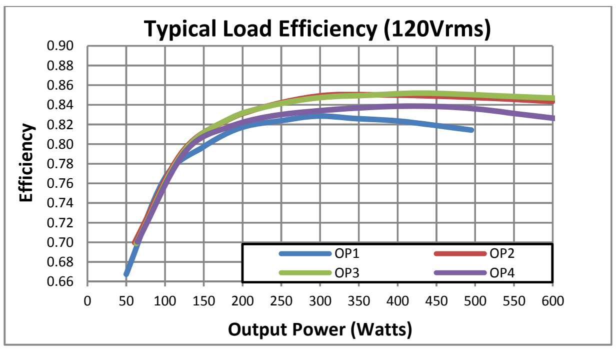
Input power rating	=	Prated*line derating factor*Temp derating factor				
Output power rating	=	Prated*Temp derating factor				
Line derating factor	=	(1-(0.007143*(120-Vin))	=	(1-(0.007143*(120-100))	=	0.85714
Temperature derating factor	=	(1-(Temp-50)*0.025)	=	(1-(60-50)*0.025)	=	0.75
Input power rating	=	600*0.85714*0.75	=	385.7W		
Output 2 power rating	=	150*0.75	=	112.5W		

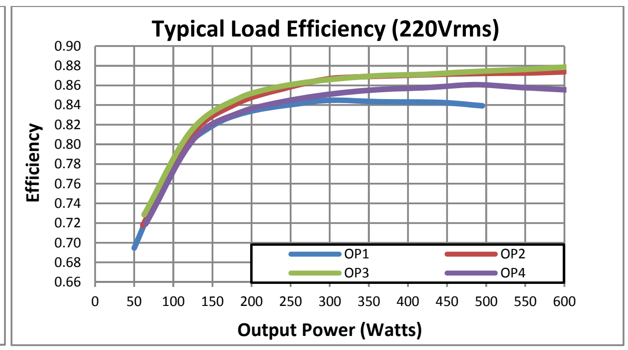
Efficiency

The efficiency of the overall unit is dependent on several parameters such as input voltage, load level and on the combination of output modules. The plots below show typical efficiencies of a NEVO+600 over the full load and line voltage range and fitted with four of each type of output module, equally loaded.









An estimate of the efficiency for any particular system may be obtained from these graphs using the procedure outlined in the example below.

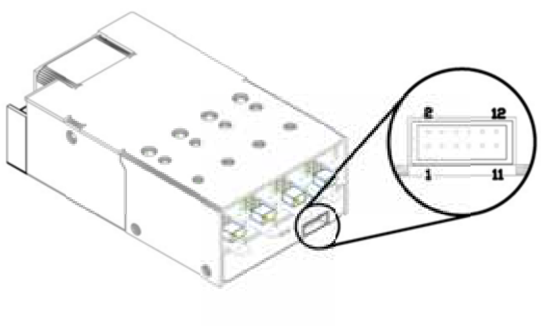
Example: Estimate the efficiency of an NEVO+600-1123, at 160Vrms input and 100W load on each output?

1. Define load efficiencies for each output module at the specified load and 220V.
2. Define change in efficiency from 220Vrms to 160Vrms for each output module.
3. Sum the values from step one and two for each output module.
4. Calculate the average efficiency for the total system.

Step	Details	Slot A OP1	Slot B OP1	Slot C OP2	Slot D OP3
1	ϵ_{220} (Load chart)	0.84	0.84	0.87	0.87
2	$\Delta\epsilon_{(220\text{-}160)}$ (Line chart)	-0.01	-0.01	-0.01	-0.01
3	$\epsilon_x = \epsilon_{220} + \Delta\epsilon_{(220\text{-}160)}$	0.83	0.83	0.86	0.86
4	$\epsilon_{AVE} = (\epsilon_1 + \epsilon_2 + \epsilon_3 + \epsilon_4)/4$	**0.845**			

Signalling

To reduce cabling in the end system, all major input and output signals and the global 5V bias supply are wired to a single signals circuit that is accessed through the connector (J2) located at the output side of the chassis as shown in the diagram below.



Pin	Name	Description	
1	PG1	Power Good	Slot A
2	INH1	Inhibit	
3	PG2	Power Good	Slot B
4	INH2	Inhibit	
5	PG3	Power Good	Slot C
6	INH3	Inhibit	
7	PG4	Power Good	Slot D
8	INH4	Inhibit	
9	GINH	Global inhibit	
10	ACOK	AC mains signal	
11	+5V	Global 5V Bias	
12	COM	Common	

All of the signals are referenced to the bias supply common rail (COM) and external control and/or monitoring circuits can be easily powered and interfaced to the PSU through this connector. The entire signals circuit is fully medically isolated and can be considered a SELV output. The table below lists the isolation voltages.

Signals isolation voltages		
Signals to Input	4000	Vac
Signals to Chassis	250	Vdc
Signals to Output	250	Vdc

5V bias supply (Power)
A 5V bias supply that can deliver up to 200mA is provided as standard on all units. This supply is available whenever the AC mains voltage is connected and the input module is operating correctly. To ensure safety, the following abnormal conditions may cause the entire unit to latch off, which will disable the 5V bias supply:

- Over temperature of any part of the unit
- Over voltage on the output
- Internal over current (device failure)

AC mains signal (ACOK [Output])
An ACOK signal is provided to indicate to the user that the AC mains voltage is applied and the input module is operating correctly. The output signal is driven from an internal operational amplifier as shown in the following diagram. Under normal operating conditions this signal gives a warning of 5ms before the output voltage falls below the power good threshold. However, to ensure safety, the following abnormal conditions may cause the entire unit to latch off without an ACOK warning:

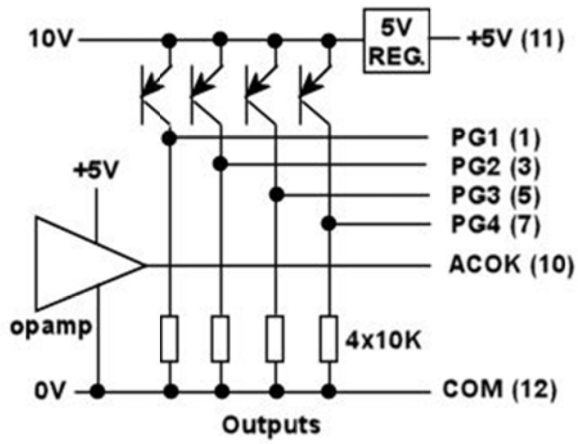
- Over temperature of any part of the unit
- Over voltage on the output
- Internal over current (device failure)

Power Good signals (PG1-PG4 [Output])

Each output module provides a power good (PG) signal to indicate when the output voltage is above approximately 90% of the preset voltage for that module. Each PG signal on an output module is internally connected through an opto-isolator to the signals circuit, which buffers the signal through a PNP transistor with a 10k pull down resistor, as shown.

The LED on the front of each module gives a visual confirmation of the PG status.

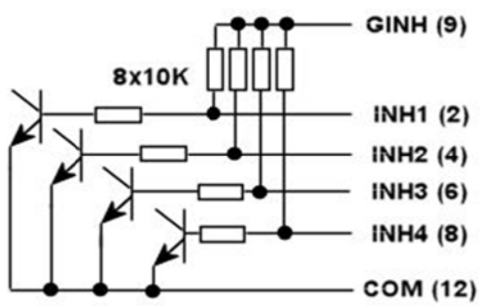
Note that remote adjustments of the output voltage using the Vcontrol and Icontrol pins do not change the PG signal threshold. The PG threshold is always approximately 90% of the voltage set with the manual potentiometer.

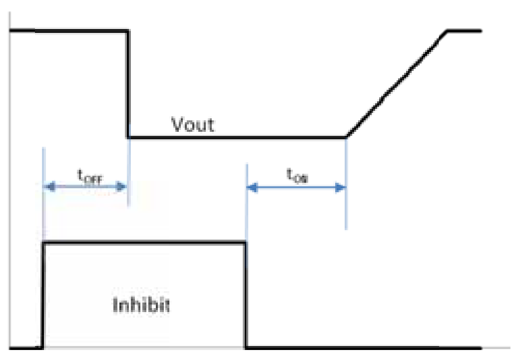


Output Inhibits (INH1-INH4, GINH [Input])

The signals circuit provides four inhibit inputs to disable each output module individually and a fifth global inhibit input (GINH) to inhibit all modules simultaneously. Each inhibit input is internally connected through an opto-isolator to the respective output modules. The basic internal electrical circuit and timing diagrams are shown below. Typically, t_{OFF} = 100 µs and t_{ON} = 8 ms.

To inhibit each output module individually, GINH should be connected to COM, and 5V applied to the appropriate input INH1/2/3/4. To start with all outputs inhibited and then enable them individually, GINH should be connected to +5V, then pull down the appropriate input INH1/2/3/4. If GINH is left unconnected, then INH1/2/3/4 will all behave as global inhibit inputs. i.e. 5V on <u>any</u> INH input will disable all outputs.

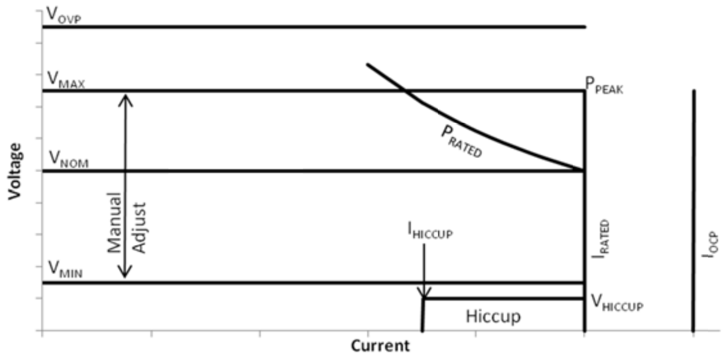




Single Output module operation

Power profile

The power profile diagram below is a voltage/current plot that together with the associated table provides details of the main features of the currently available output modules.



Parameter	OP1	OP2	OP3	OP4
V_{NOM} (V)	5	12	24	48
V_{MIN} (V)	1.5	4.5	9	18
V_{MAX} (V)	7.5	15	30	58
V_{OVP} (V)	9.5	17	32	62
I_{RATED} (A)	25	15	7.5	3.75
I_{OCP} (A)	27.5	16.5	8.25	4.125
V_{HICCUP} (V)	1	2	4	4
I_{HICCUP} (A)	22	13.2	6.6	3.3
P_{RATED} (W)	125	150	150	150
P_{PEAK} (W)	187.5	225	225	217.5

Output voltage adjustment

Each output can be adjusted within the range as described in the table above or in the datasheet. Voltage adjustment can be achieved by two methods;

1. **Manual potentiometer adjustment**

Using the manual adjust potentiometer, the preset output voltage (V_{SET}) of each output module is adjustable over the entire range of V_{MIN} to V_{MAX} as specified in the power profile table above. A clockwise rotation of the potentiometer results in an increase of the output voltage while an anti-clockwise rotation results in a decrease of the output voltage.

2. **Remote voltage programming**

Using remote voltage programming, the output voltage may be adjusted beyond the V_{MIN} and V_{MAX} range specified in the power profile table above. However, certain precautions must be taken to ensure correct operation. Please see the "Advanced output module features" section for more details.

Over Voltage Protection (OVP)

In the event of an output module fault, the modules are protected against excessive output voltages. This is implemented as a fixed voltage threshold (V_{OVP}, in the table above) and if the output voltage exceeds this threshold the entire chassis will be latched off. To resume operation of the unit, disconnect the AC input voltage for 2 minutes, remove the faulty output module and reconnect the AC input voltage.
Note that no warning is given on the AC_OK signal for faults of this type.

Over Current & Short Circuit Protection (OCP & SCP)

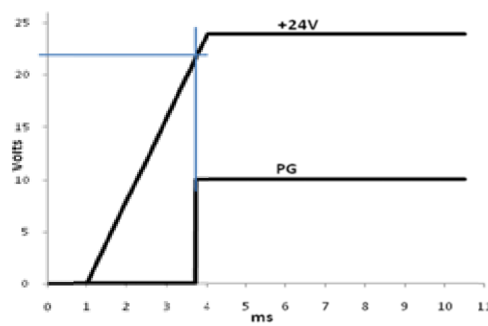
For increased safety and reliability all output modules in the NEVO series have over current and short circuit protection. The over current threshold is typically set at 110% of the rated current and has a constant current, straight line characteristic that reduces the output voltage as the load resistance decreases. If the output voltages falls below the hiccup voltage threshold (V_{HICCUP}) the module enters short circuit protection mode. In this mode the output module uses a hiccup scheme to reduce system losses and potential damage. When in this mode, the output will be enabled for approximately 3% of the time, disabled for 97% and will attempt to restart at approximately 125 ms intervals. The module remains in this state until the short circuit condition is removed, at which point the module returns to normal operation.

Reverse Current Protection (RCP)
The standard output modules use synchronous rectification in the output stages to achieve high efficiency and as a result the outputs can both source and sink current. The sink current is internally limited to approximately -6% of the maximum rated current. However, in applications where the output modules are connected to external power sources such as batteries or other power supplies certain precautions must be observed to prevent damage to the unit.

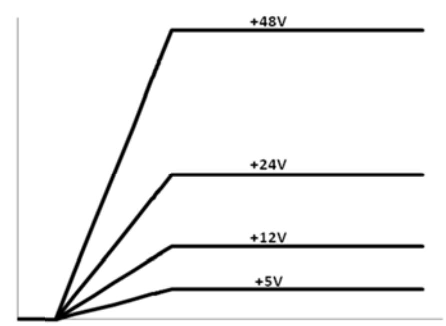
The outputs should never be directly connected to to external power sources without some form of reverse current protection such as an external diode or controlled mosfet. If protection is not used, large reverse currents which will ultimately result in damage to the unit will occur, especially when the AC mains is disconnected.

Output module Average and Peak power
All modules have an average and peak power rating. The average power of each unit must at all times remain below it's specified limit. However, each output can deliver up to 150% of it's average power rating for a maximum of 5 seconds at 50% duty cycle, subject to the current limit not being exceeded and subject to the overall average power drawn being less than the specified average power rating (including any input derating due to temperature or line voltage). The available peak power is a function of the output voltage and maximum current for each module. Full peak power is only possible when the output voltage is adjusted to V_{MAX} and the maximum current is drawn from the module. Note that both average and peak power ratings are subject to the same temperature derating as the input module (derate by 2.5% per °C above 50°C), but are not subject to any line derating.

Start up & Shut down
All outputs are designed to have a regulated monotonic start-up with a rise time of approximately 3 ms as shown in the diagram right. The power good signal stays low until the voltage exceeds the power good threshold (≈90%).



Where multiple output modules are used, the default start up scheme is ratio-metric with all outputs starting at the same time as shown in the diagram right. External control circuits may be used to implement tracking or sequenced start up if necessary.



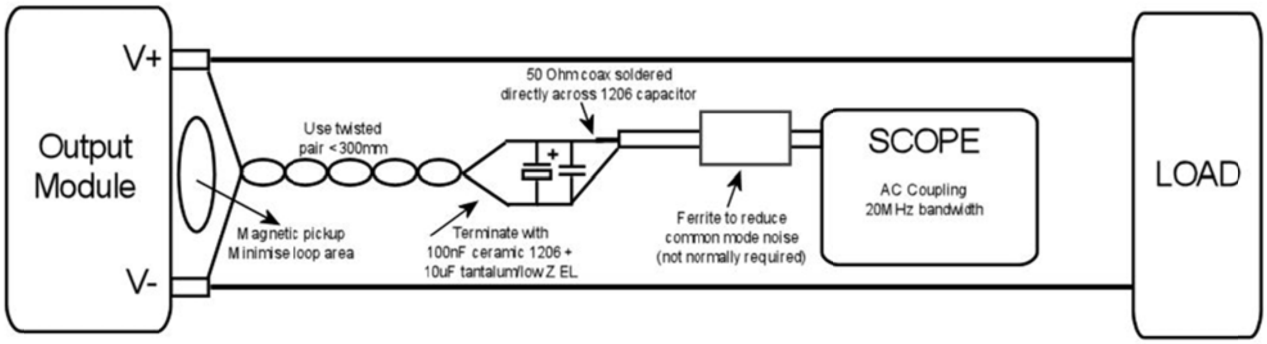
The outputs are not designed to start into a pre-biased load and may discharge any externally capacitance before beginning to ramp the output voltage up in the normal way.

At shutdown the outputs enter a high impedance state. Where no external load is present it may take some time for the voltage to decay. When driving inductive loads, care must be taken to limit the voltage at the output terminals so as to prevent damage to the unit.

Synchronisation
All output modules in the same chassis are synchronised. The typical operating frequency is 260kHz and paralleled/seriesed units will not produce beat frequencies.

Ripple and Noise

The ripple and noise figures stated in the datasheet are defined based on a standard measuring method. To obtain the same results the same test setup must be used and care must be taken to eliminate any parasitic noise pickup. The diagram below shows details of the setup and also sources of noise pickup.



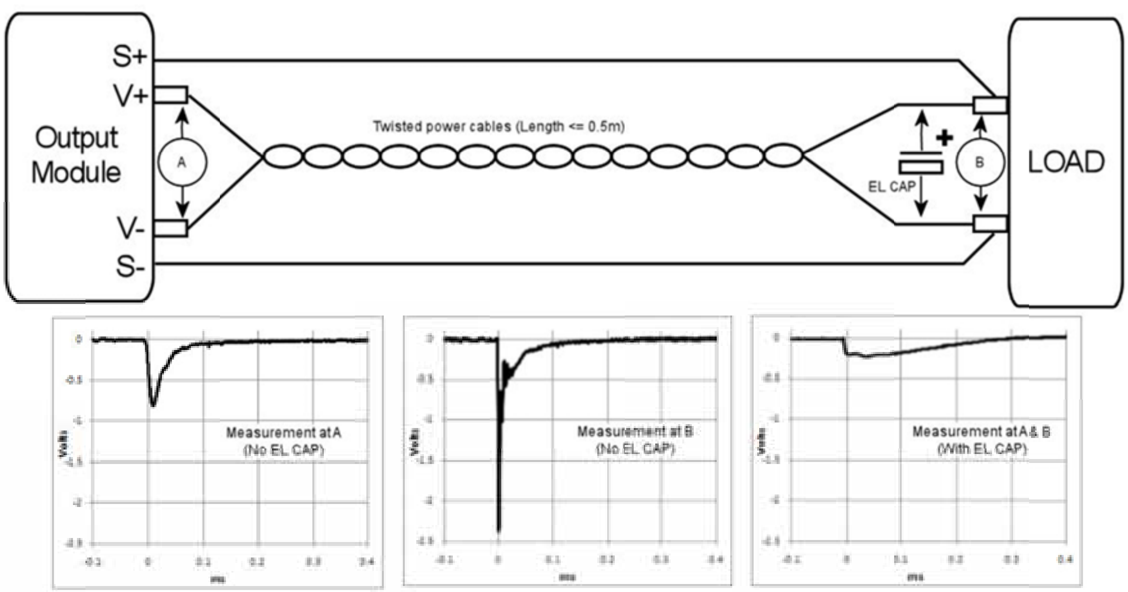
Over Temperature Protection (OTP)

Each output module is protected against excessive temperatures. In the event of the internal temperatures exceeding safe levels the entire unit may be latched off. To resume operation of the unit, disconnect the AC input voltage for 2 minutes, ensure external ambient temperatures are within specifications and then reconnect the AC input voltage. Note that no warning is given on the AC_OK signal for faults of this type.

Transient response

The NEVO output modules have been especially designed to have high reliability and to achieve this all electrolytic capacitors have been eliminated from the design. Due to this, high dynamic load transients can cause relatively high voltage deviations at the output and although the outputs have a very high loop bandwidth with typical recovery times of less than 100µs, the voltage deviations may still be excessive for some applications.

An example application is detailed in the diagram below and shows typical responses at the terminals of the output module and at the load. Notice that the voltage deviation due to cable inductance exceeds the module response and hence a capacitor located at the module terminals will have little effect at the load. The optimum solution is to locate a low impedance electrolytic capacitor at the load which will eliminate the inductive cable drop and also reduce the typical voltage deviation at the module.

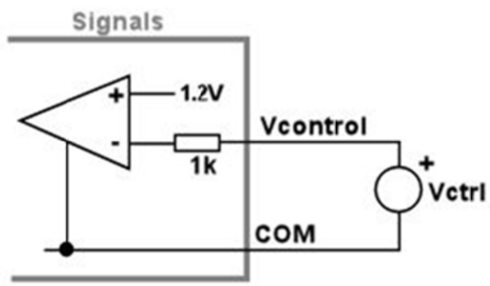


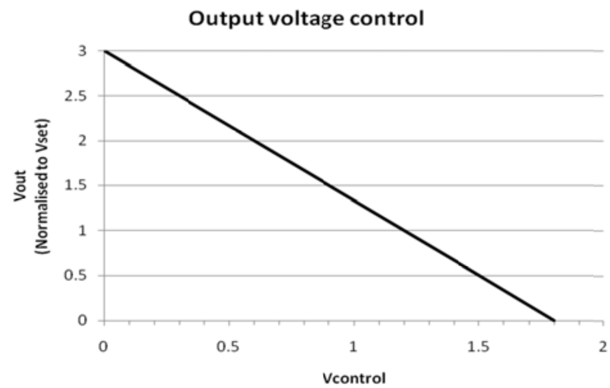
Advanced Single Output module features

Remote voltage programming (External voltage control)
The output voltage of the module can be adjusted using an external voltage source connected between the COM and Vcontrol pins on the signals connector J5 as shown below.

In this configuration the output voltage will follow the typical equation below,

Vo = Vset((1.8-Vctrl) / 0.6), where Vset is the manual preset voltage of the module.





The output voltage can be controlled from 0% to 300% of the preset voltage using this control method. However, care must be taken to ensure the output voltage does not exceeed the OVP level, as this is considered a safety hazzard and will latch the entire unit off. To determine the level of control voltage that will trigger OVP, insert Vovp into the equation above.

Example: Vovp = 9.5V, Vset = 5V;

=> Vctrl = 1.8-(Vovp*0.6/Vset) = 0.66V

Hence, Vctrl should never fall below 0.66V, otherwise OVP may latch the entire unit off.

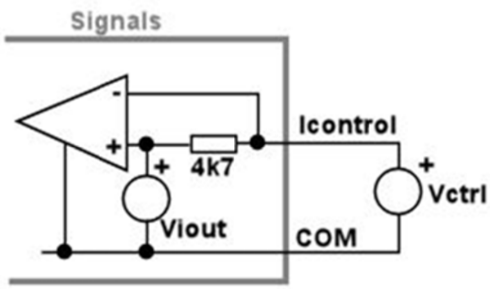
Alternatively, by manually adjusting the output voltage to less than 1/3rd of the OVP voltage ensures that OVP can never be tripped by remote voltage control.

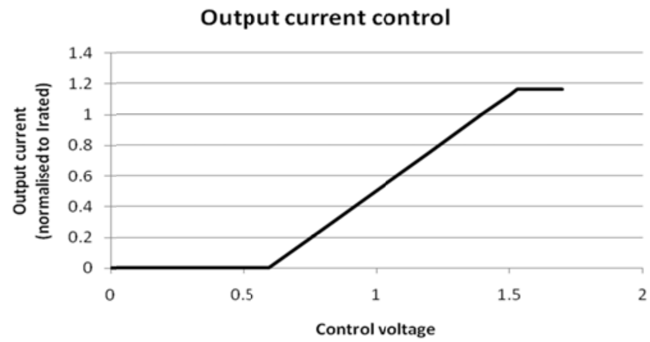
Also, remote adjustment of the output voltage using the Vcontrol pin does not affect the preset power good threshold. Hence, remotely adjusting the output voltage below 0.9*Vset will cause the power good signal to go low.

Where tight voltage adjustment tolerances are required, it is recommended to use external circuitry to provide closed loop control of the Vcontrol pin.

Remote current programming (External voltage control)

The output current limit of the module can be reduced using an external voltage source connected between the COM and Icontrol pins on the signals connector as shown below. In practice this also means that the output can be used as a modulated or constant current source.





In the diagram above, Vi_out is an internal voltage source that is proportional to the internal inductor current and <u>approximates</u> the equation,

$V_{i\_out} = 0.6 + (I_{out}/(I_{rated}*1.25))$, where Irated is the maximum rated current for the module.

In this configuration the output current limit will <u>approximate</u> the following equation,

$I_{limit} = (Vctrl-0.6)*I_{rated}*1.25$, where I_{rated} is the maximum rated current for the module.

It is not possible to increase the maximum current limit of the module, and control voltages (V_{ctrl}) exceeding 1.53 V will have no effect on the current limit.

When using an output module as a modulated current source, the output voltage should be manually adjusted to the maximum that will be required by the application and this will be the upper voltage limit. Once the load is connected, the output current can then be modulated by applying a control voltage as described above.

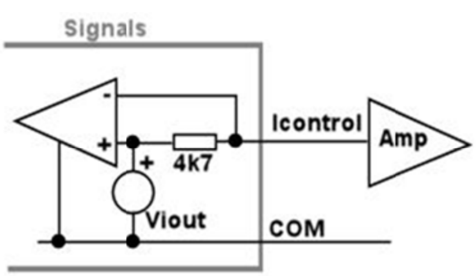
Note that the power-good threshold level is fixed and defined by the manually preset voltage. Hence, while the output module is limiting or modulating the output current the PG signal may go low.

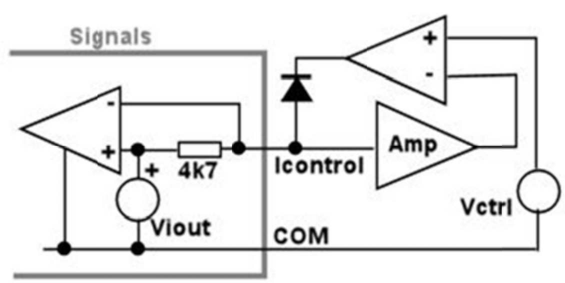
Where tight current adjustment tolerances are required, it is recommended to use external circuitry to provide closed loop control of the Icontrol pin.

Output current measurement

The output current of the module can be measured using the $I_{control}$ signal. If this pin is unloaded its output voltage will follow the equation,

$V_{i\_out} = 0.6 + (I_{out}/(I_{rated}*1.25))$, where I_{rated} is the maximum rated current for the module.



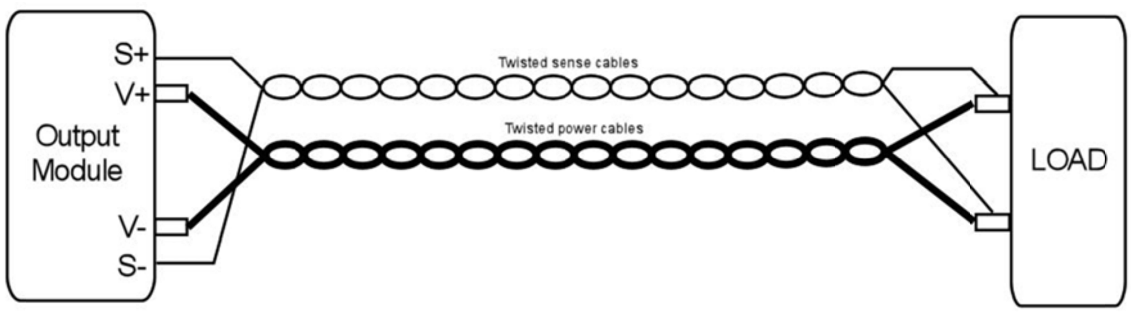


Note that the $I_{control}$ output voltage is representative of the internal inductor current not the actual load current. However, this will only have an influence during dynamic events. It is recommended to add an external amplifier (as shown above left)

when using the $I_{control}$ signal to measure the output current as loading the $I_{control}$ signal, even with microamps can cause the current limit to be reduced. If it is required to measure the output current and adjust the output current limit simultaneously, this can be achieved by using a clamp circuit instead of a voltage source to adjust the current limit, while continuing to use an amplifier to measure the output current. An example circuit is shown above right. In this case V_{ctrl} will control the current limit while the amplified $I_{control}$ signal will provide a measurement of the output current.

Remote sensing

Remote sensing is available on all output modules and can be used to compensate for any voltage drop in the main power leads between the power supply and the load. To implement remote sensing connect the positive sense pin (S+, connector J5.2) to the positive side of the remote load and the negative sense pin (S-, connector J5.1) to the negative side of the remote load. The voltage will be regulated at the points where the sense cables are connected.



Active protection against worn out power cables or accidental power cable removal is provided and prevents damage to the unit in each case. An internal circuit measures the voltage between S+ to V+ and S- to V-, when this voltage exceeds the thresholds specified in the datasheet, the output voltage is reduced to benign levels. During system design, care must be taken to ensure power cables have a sufficiently low voltage drop at maximum load current to ensure this protection does not activate unintentionally.

In systems where remote sensing is not used, the output voltage at the power terminals will be slightly higher than that at the sense terminals. This voltage difference is termed, open sense offset and occurs due to internal bias currents in the sensing circuit. Factory set units are set with the sense cables connected unless otherwise specified.

Local Bias supply

A local non-isolated +5 V bias supply is provided on each output module (+5 V on J5.6, referenced to COM on J5.5). This supply is intended to power interface circuits for monitoring and controlling the output modules, such as amplifying the current output signal as described earlier. The output can supply up to 10mA maximum, and exceeding this can damage the unit.

Also, as COM is connected to an internal voltage that is **NOT** equivalent to S- or V-, particular attention must be given to grounding issues when interfacing COM to any control circuit in the application. Connecting COM to S- or V- may result in damage to the unit.

Series Connected outputs

NEVO output modules of the same type can be seriesed in any number to achieve higher output voltages, even across multiple chassis! The following instructions must be followed for output modules configured in this manner.

WARNING!
Energy and voltage hazards may arise when individual modules are seriesed.
See the Safety section for more details.

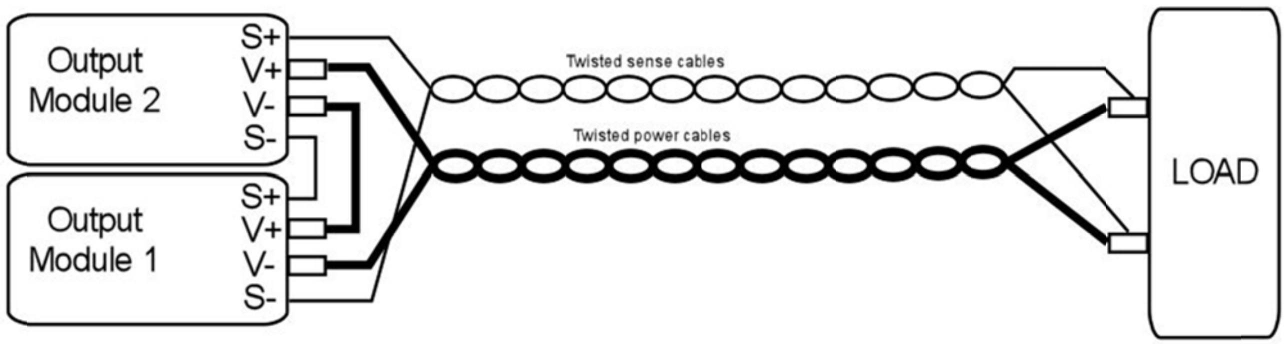
WARNING!
When modules are seriesed, their inhibit lines (J2), if used, should be paralleled.
Inhibiting seriesed modules individually may cause damage

Isolation to ground

Care must be taken not to exceed the output module isolation to chassis ground when seriesing outputs. Each output is rated for 250 volts maximum between each output terminal and chassis ground. Exceeding this voltage may damage the unit.

Remote sensing

For seriesed modules, remote sensing is achieved by connecting the upper most positive sense terminal (S+) and the lower most negative sense terminal (S-) from the series of modules to their respective load regulation points. All inner sense terminals in the series must be daisy chained, S+ to S- from the first module in the series to the last module in the series. An example of two seriesed modules is shown below.



Seriesed remote voltage / current control

Remote voltage and/or current control is possible with series connected output modules using the advanced V-control and I-control functions as described earlier. However, individual control of each module can be complex as the various control terminals are referenced to the positive output of the preceding module and require the use of multiple isolated control voltages to attain control over the full voltage range. In practice, individual control of each module is rarely required and a more straightforward method is to control all outputs simultaneously with a single control voltage. With NEVO output modules this is achieved with the use of the Nevo Series Tracker Interface, the datasheet for this interface is available from the Vox Power website i.e. www.vox-power.com. By using the series tracker interface all modules in a series can be controlled by a single control voltage that can be referenced to the COM (J5.5) pin on any module.

SELV precautions

Where series combinations of output modules exceed 60 V, the output can no longer be considered SELV (Safety Extra Low Voltage) and hence the final equipment manufacturer must provide suitable protection for both users and service personnel.

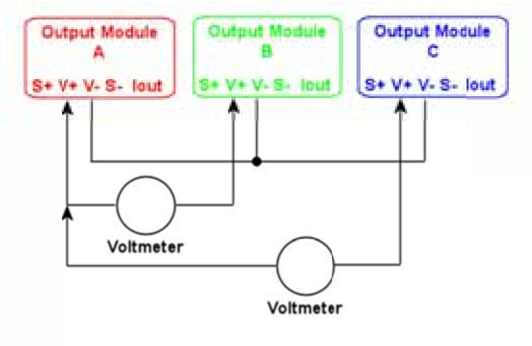
Paralleled outputs

NEVO single type output modules of the same type can be paralleled in any number within the same chassis to achieve higher output currents.

WARNING!
Energy hazards may arise when individual modules are paralleled.
See the Safety section for more details.

WARNING!
When modules are paralleled, their inhibit lines (J2), if used, should also be paralleled.
Inhibiting paralleled modules individually may cause damage

For best performance, the output voltages of each paralleled module should be adjusted as close as possible.
Follow the procedure below to achieve the most accurate results:

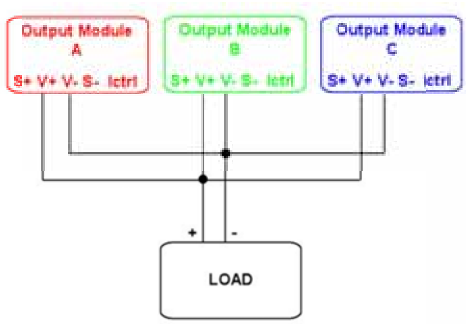


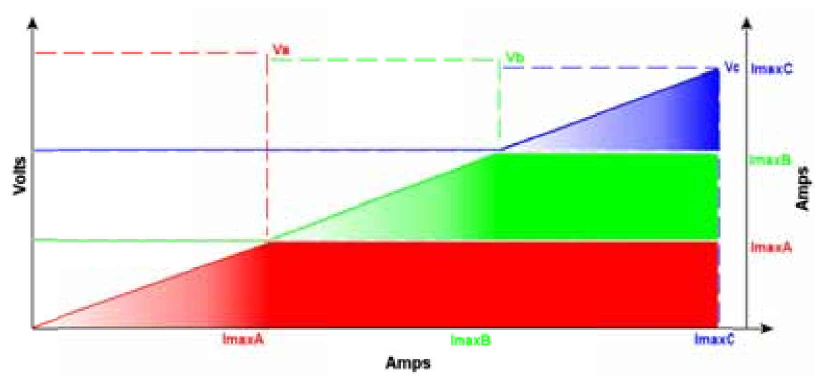
1. Connect all the negative power cables together.
2. Adjust the first module (A) to the desired voltage.
3. Connect a voltmeter between the positive terminal of the first module (A) and the positive terminal of the second module (B) and adjust the second module (B) until the voltage is within +/-0.2%..
4. Repeat step 3 for the remaining modules, always using the positive terminal of the first module (A) as the reference.

When paralleled, the outputs can operate in two distinct modes, Normal parallel mode or Share parallel mode.

Normal parallel mode

For normal parallel mode, the positive power cables should be connected together and the negative power cables should be connected together. No other connections are required as shown in the diagram below.





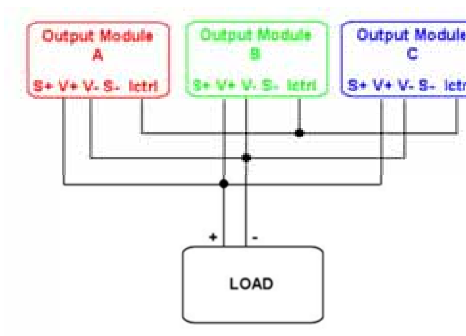
In this mode the highest adjusted output module will supply all of the load current until it's current limit is reached. If the load demand exceeds this level the output voltage will drop to the level of the next highest adjusted module and that module will begin to supply the load current while the first module continues delivering full current. This process repeats for the total number of paralleled modules. The diagram above shows the VI curve for such a system.

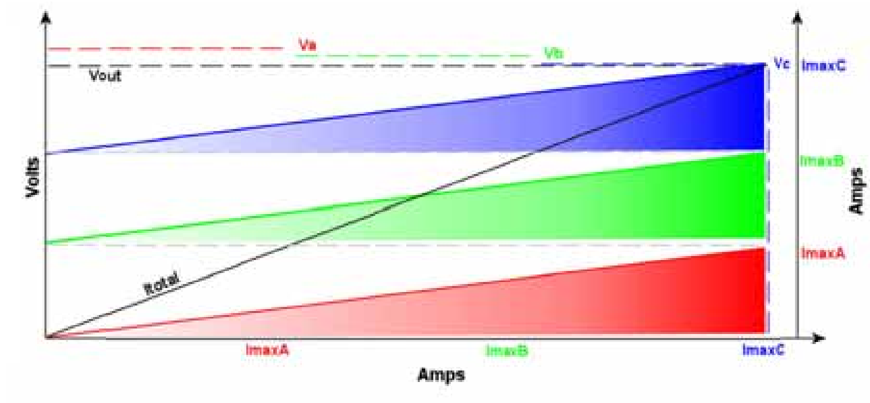
Output modules that are not delivering current will typically sink a small amount of current from the other outputs, but this will not exceed -6% of each modules maximum rated current.

Typically, system reliability is reduced in this mode as the higher adjusted modules will do most of the work with the lower adjusted modules only delivering current during peak load demand.

Share parallel mode

In Share parallel mode, the outputs are paralleled as before and the Icontrol pin for each module is connected together as shown in the diagram below.





Connecting the Icontrol pins together forces all the outputs to deliver the same current, ensuring that the system reliability is maximised and the work load is distributed evenly across all paralleled modules.

In this mode the lowest adjusted output module will determine the actual output voltage and all higher adjusted outputs will reduce their voltage. There may be a small amount of circulating current between the modules, approximately 6% of the maximum rated current for each module.

The current output signal (Icontrol) can still be used to measure the output current but it must be scaled by N, where N is the number of paralleled modules.

WARNING!

Care must be taken to avoid differential voltages between the negative power output terminals of the paralleled modules as this can cause errors at the control pins. To avoid this, it is recommended that a low impedance connection be made between the negative power terminals close to the PSU output and cables then connected from this common point to the load.

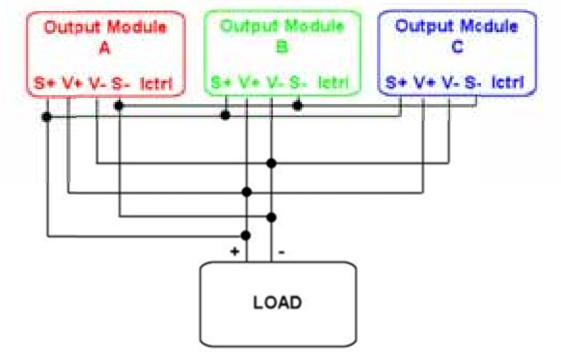
Paralleling across multiple chassis

Paralleling across multiple chassis is not possible without external protection (such as external diodes or controlled MOSFETs) to prevent circulating currents between each chassis. Failure to provide such protection may result in damage to the units. Consult Vox Power for details on how best to implement such applications.

Where units are paralleled across multiple chassis, the outputs in each chassis will not be synchronised and the peak to peak output ripple may contain beat frequencies in the audio spectrum.

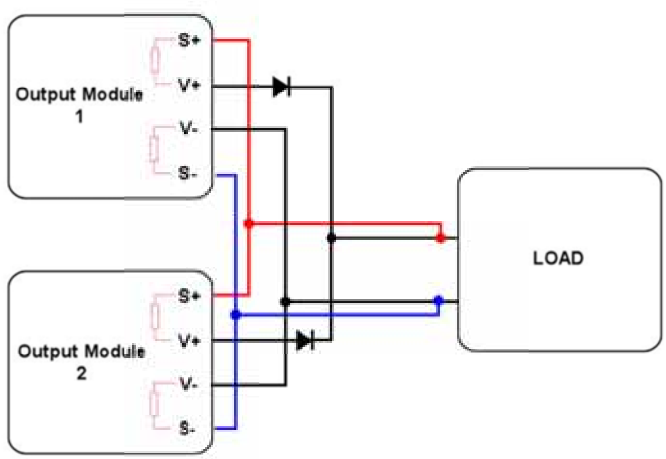
Parallel remote sensing

Remote sensing can be used as normal with paralleled modules. The sense lines (S+ and S-) from each of the output modules should be connected together, S+ to S+, and S- to S- as shown below. This should be done close to the power supply output and a single pair of cables brought from these sense lines to the load. Keeping cable lengths to a minimum and using twisted pairs where necessary will help reduce noise pickup in the sense lines.



N+1 configurations

When using N+1 redundant configurations, a suitably rated diode (or controlled MOSFET) must be used on each output to prevent a device failure from causing a system failure. However, the diode introduces voltage drops between the supply and the load that significantly degrade the load regulation. To counteract this, the remote sense lines can be used to regulate the voltage at the load as shown below.

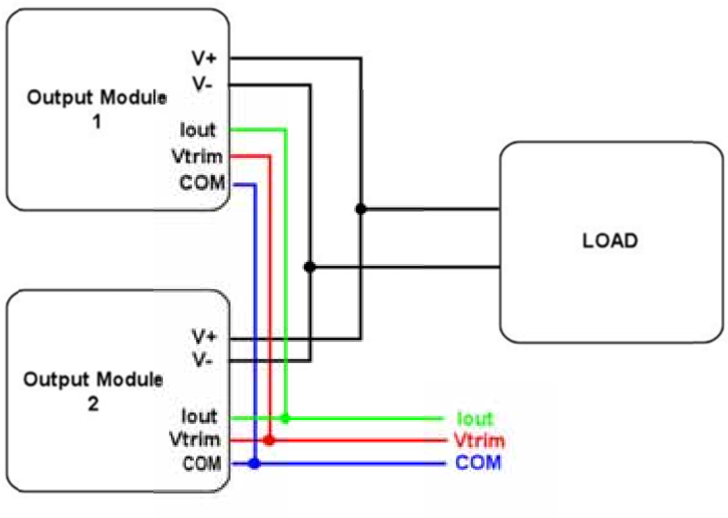


Typically, this configuration can damage the internal sense resistors used within a power supply. However, the NEVO outputs have integrated protection to prevent this type of damage and are completely N+1 compatible without any additional external protection circuitry. Note that only the positive sense terminal is protected and diodes should be used in the positive connection only.

Paralleled remote voltage/current adjust

The simplest way to achieve remote voltage/current programming with paralleled outputs is to operate the modules in share parallel mode. Follow the procedure outlined earlier to configure the outputs in share parallel mode and once configured in this mode, all the Vcontrol and COM pins can be connected together. Remote voltage/current programming can then be performed exactly as with a stand-alone module.

It is not recommended to use remote voltage/current programming in normal parallel mode.



WARNING!

Care must be taken to avoid differential voltages between the negative power output terminals of the paralleled modules as this can cause errors at the control pins. To avoid this, it is recommended that a low impedance connection be made between the negative power terminals close to the PSU output and cables then connected from this common point to the load.

Dual Output module operation

Power profile

The power profile diagram below is a voltage/current plot that together with the associated table provides details of the main features of the currently available dual output modules.

Parameter	OP5		OP6		OP7	
Channel	Top	Bottom	Top	Bottom	Top	Bottom
V_{NOM} (V)	12	12	3.3	3.3	3.3	12
V_{MIN} (V)	5	5	1.8	1.8	1.8	5
V_{MAX} (V)	15	15	5	5	5	15
V_{OVP} (V)	20	20	8	8	8	20
I_{RATED} (A)	5	5	5	5	5	5
I_{OCP} (A)	5.25	5.25	5.25	5.25	5.25	5.25
P_{RATED} (W)	75	75	25	25	25	75

Output voltage adjustment

Each output can be adjusted within the range as described in the table above or in the datasheet. Voltage adjustment can be achieved using the manual adjust potentiometer, the preset output voltage (V_{SET}) of each output module is adjustable over the entire range of V_{MIN} to V_{MAX} as specified in the power profile table above. A clockwise rotation of the potentiometer results in an increase of the output voltage while an anti-clockwise rotation results in a decrease of the output voltage.

Remote voltage programming is not available on dual output modules.

Over Voltage Protection (OVP)

In the event of an output module fault, the modules are protected against excessive output voltages. This is implemented as a fixed voltage threshold (V_{OVP}, in the table above) and if the output voltage exceeds this threshold the entire chassis will be latched off. To resume operation of the unit, disconnect the AC input voltage for 2 minutes, remove the faulty output module and reconnect the AC input voltage.
Note that no warning is given on the AC_OK signal for faults of this type.

Over Current Protection (OCP)

For increased safety and reliability all dual output modules in the NEVO series have over current protection. The over current threshold is typically set at 105% of the rated current and has a hiccup mode characteristic that turns off the output if the load current exceeds the threshold. The output will remain off for a certain period and then attempt to restart. The module remains in this state until the over load condition is removed, at which point the module returns to normal operation.

Note that hiccup mode current limit schemes can cause startup issues in certain circumstances where load currents plus any capacitive charging currents exceed the current limit. For reliable designs the user should ensure the worst case measured startup current does not exceed 90% of the rated current.

Reverse Current Protection (RCP)
Nevo Dual output modules use synchronous rectification in the output stages to achieve high efficiency and as a result the outputs can both source and sink current. The sink current is internally limited to approximately -6% of the maximum rated current.

Dual output modules should never be directly connected to to external power sources without some form of reverse current protection such as an external diode or controlled mosfet. If protection is not used, large reverse currents which will ultimately result in damage to the unit will occur, especially when the AC mains is disconnected.

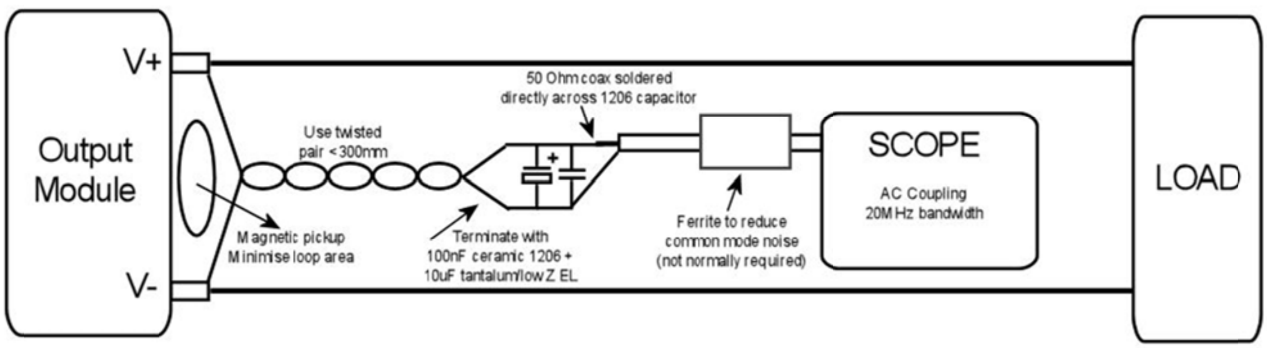
Start up & Shut down
All outputs are designed to have a regulated monotonic start-up with a controlled rise time which is specified in the datasheet. The power good signal stays low until the voltage for both outputs is with the power good threshold range (≈68% to 120%).

Dual outputs are not designed to start into a pre-biased load and may discharge any externally capacitance before beginning to ramp the output voltage up in the normal way.

At shutdown the outputs enter a high impedance state. Where no external load is present it may take some time for the voltage to decay. When driving inductive loads, care must be taken to limit the voltage at the output terminals so as to prevent damage to the unit.

Synchronisation
All dual output modules in the same chassis are synchronised. The typical operating frequency is 260kHz and seriesed units will not produce beat frequencies.

Ripple and Noise
The ripple and noise figures stated in the datasheet are defined based on a standard measuring method. To obtain the same results the same test setup must be used and care must be taken to eliminate any parasitic noise pickup. The diagram below shows details of the setup and also sources of noise pickup.



Over Temperature Protection (OTP)
Each output module is protected against excessive temperatures. In the event of the internal temperatures exceeding safe levels the entire unit may be latched off. To resume operation of the unit, disconnect the AC input voltage for 2 minutes, ensure external ambient temperatures are within specifications and then reconnect the AC input voltage. Note that no warning is given on the AC_OK signal for faults of this type.

Transient response
The NEVO Dual output modules have been especially designed to have high reliability and to achieve this all electrolytic capacitors have been eliminated from the design. As a result, the typical output capacitance of the module is relatively low and high dynamic load transients can cause relatively high voltage deviations at the output. Where this causes an application issue, external low impedance electrolytic capacitance may be added to improve the transient response.

However, for Dual output modules the maximum recommended external capacitance is 220uF. Exceeding this value may cause startup issues.

Parallel operation
Nevo Dual Output modules cannot be paralleled. Paralleling dual output modules may result in damage.

Seriesed operation
Nevo Dual Output modules can be seriesed.

Temperature Derating
For Dual Output modules the temperature derating factor applies to output current not output power.

Remote sensing

Remote sensing is available on all Dual output modules and can be used to compensate for a small voltage drop in the main power leads between the power supply and the load. To implement remote sensing connect the positive sense pin [S+, connector J5.1 (Top) or J5.3 (Bottom)] to the positive side of the remote load and the negative sense pin [S-, connector J5.2 (Top) or J5.5 (Bottom)] to the negative side of the remote load. The voltage will be regulated at the points where the sense cables are connected.

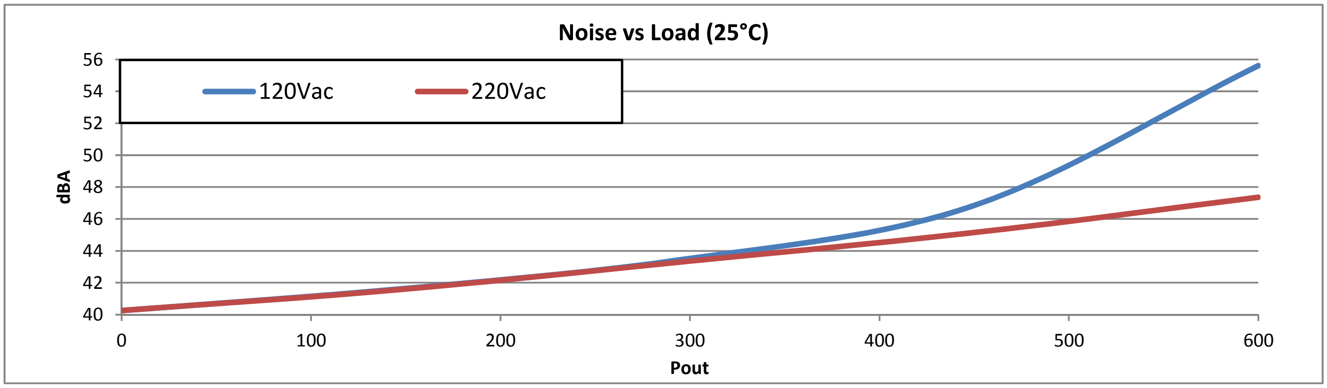
In systems where remote sensing is not used, the output voltage at the power terminals will be slightly higher than that at the sense terminals. This voltage difference is termed, open sense offset and occurs due to internal bias currents in the sensing circuit. Factory set units are set with the sense cables connected unless otherwise specified.

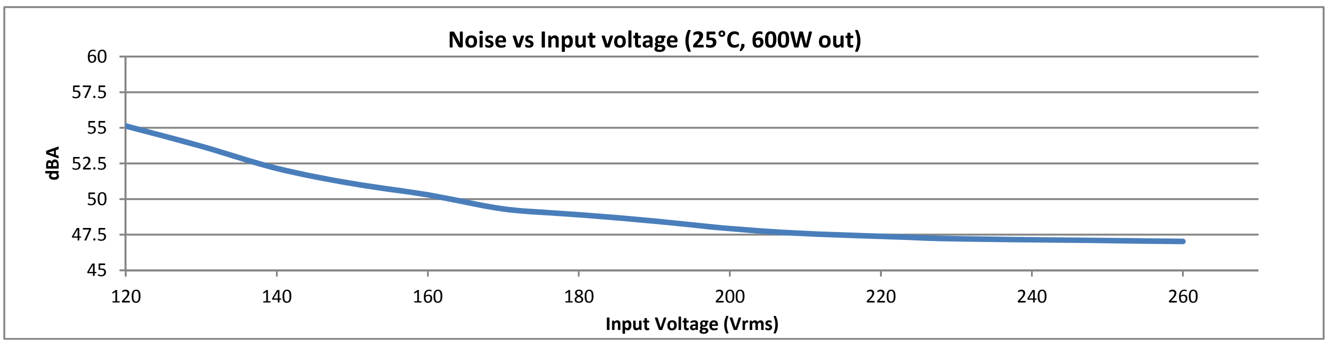
Isolation

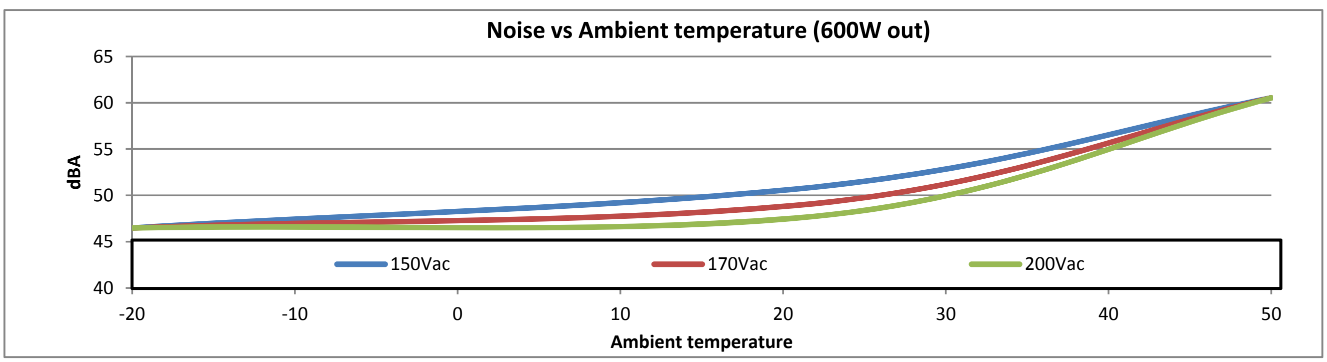
Each output channel in a Nevo Dual output module is fully isolated. Each output is rated for 250 volts maximum between each output terminal and chassis ground. Exceeding this voltage may damage the unit.

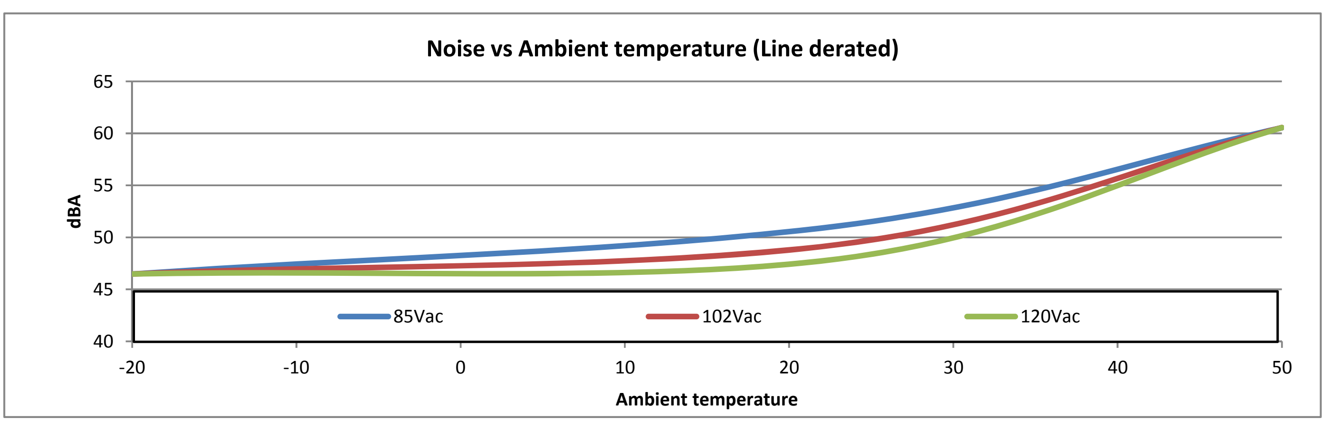
Audible noise

The following series of plots characterise the audible noise from the NEVO+1200 power supply over various conditions. These plots can be used to estimate the actual audible noise for any application.

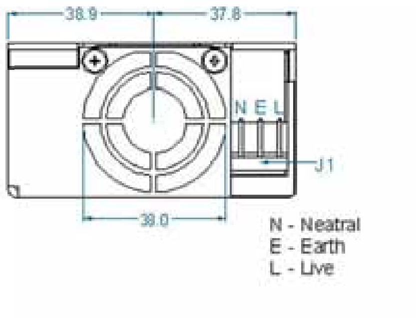




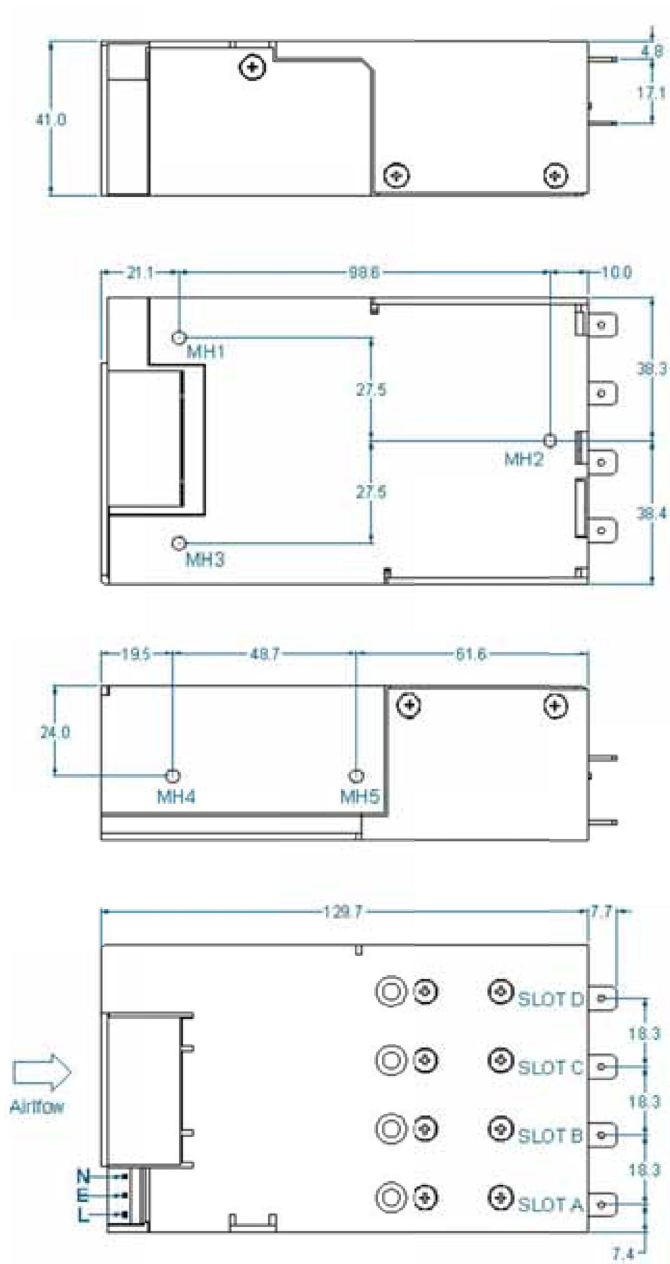




Mechanical dimensions and mounting

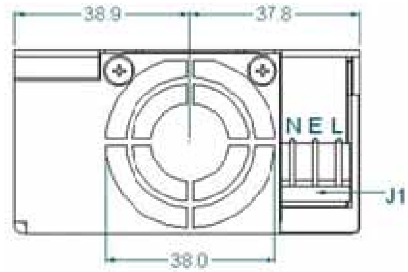


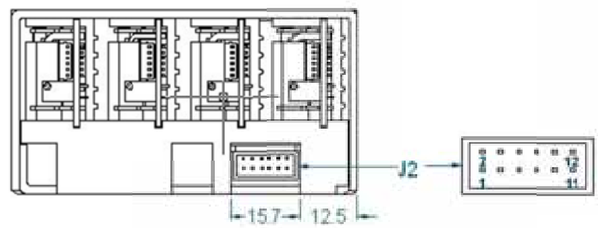
SCREWS	
MH1, MH2, MH3, MH4, MH5	
Screw type	M4
Tightening	Tighten to 1.5 Nm
Penetration depth	4.00mm max including chassis
OUTPUT MODULES x 8	
Screw type	M3x5, C/Sink, Posi, Stainless Steel
Tightening	Tighten to 0.75 Nm
Penetration depth	Defined by screw
CHASSIS x 5	
Screw type	M3x5, C/Sink, Posi, Stainless Steel
Tightening	Tighten to 0.75 Nm
Penetration depth	Defined by screw
FAN x 2	
Screw type	M3x24, C/Sink, Posi, Stainless Steel
Tightening	Tighten to 0.75 Nm
Penetration depth	Defined by screw

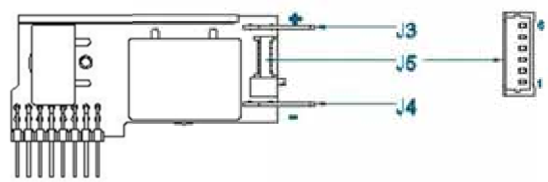


Connectors

PINOUTS		
J1		
Circuit	Details	
1	Live	
2	Earth	
3	Neutral	
J2		
Circuit	Details	
1	Power Good	Slot A
2	Inhibit	
3	Power Good	Slot B
4	Inhibit	
5	Power Good	Slot C
6	Inhibit	
7	Power Good	Slot D
8	Inhibit	
9	Global Inhibit	
10	AC OK	
11	+5V 200mA Bias Supply	
12	COM	
J3		
Circuit	Details	
1	Positive Output	
J4		
Circuit	Details	
1	Negative Output	
J5		
Circuit	Details	
1	- Sense	
2	+ Sense	
3	Voltage Control	
4	Current Control / Share / Out	
5	COM	
6	+5V local bias supply	







MATING PART DETAILS

REF.	DETAILS	MANUFACTURER	HOUSING	TERMINAL
J1	MAINS INPUT: 3 Pin, 5.08mm, with Friction Lock, 18-24 AWG	MOLEX	10013036	8701031
J2	GLOBAL SIGNALS: 12 Pin, 2mm, with Friction Lock, 24-30 AWG	MOLEX	511101260	503948051
J2	IDT ALTERNATIVE FOR J2	MOLEX	875681273	N/A
J3/J4(1)	OUTPUT POWER TERMINAL: TAB SIZE 6.35mmx0.8mm	VARIOUS	N/A	N/A
J5	OUTPUT SIGNALS: 6 Pin, 1.25mm, with Friction lock, 28-32 AWG	MOLEX	1510210600	50058800

Notes
1. Terminal and Wire current rating must exceed maximum short circuit output current. Eg. Output 1 = 25A*1.25 = 31.25Amps
2. Direct equivalents may be used for any connector parts
3. All cables must be rated 105°C min, equivalent to UL1015

Configuring your power supply

The NEVO+600 power supply is designed to be used as part of an end-system in a restricted environment and therefore should only be accessible to qualified and trained personnel. Persons attempting to configure a unit must have the necessary knowledge and training before doing so. Incorrect configuration may cause damage to the power supply and may affect the warranty of the power supply.

Output power modules may be added, replaced or moved by strictly following the sequence of operations described below. Please contact Vox Power or your distributor for assistance in configuring your power supply.

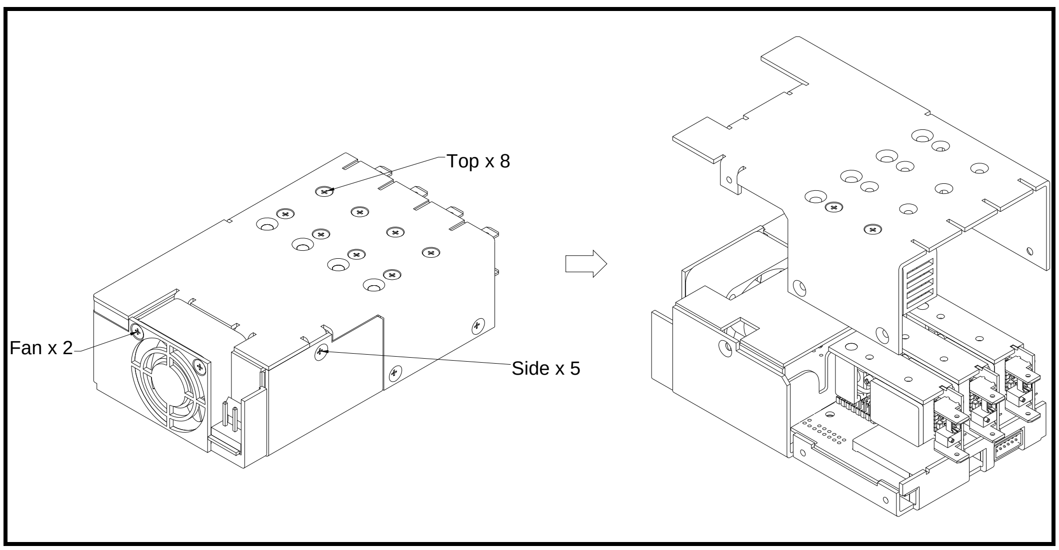
STEP 1:

Remove the power connection and all other connections from the power supply.

WARNING! Leave the unit to stand for a minimum of 3 minutes after removing all power and other connections from the unit before attempting to configure or re-configure the power supply.
Always remove the power before handling the unit. During operation the external surface of the unit can become hot. Leave to stand for 10 minutes to allow the unit to cool down before handling the unit.
Dangerous voltages are present within the power supply. Covers may only be removed by qualified personnel when the power supply has been disconnected from the mains supply voltage for more than 3 minutes. Covers must be replaced and all screws secured properly before reconnecting to the mains voltage.

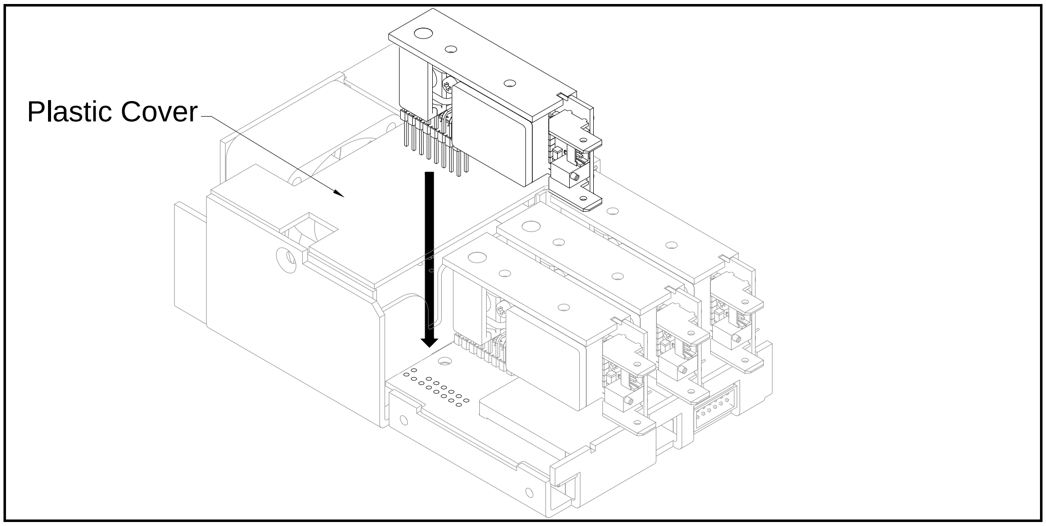
STEP 2:

Remove all screws. There are 2 screws at the fan side, 5 screws on the sides and 8 on the top (2 for each slot). The lid can now be removed. Ensure that all the output modules are loose from the lid before removing the lid.



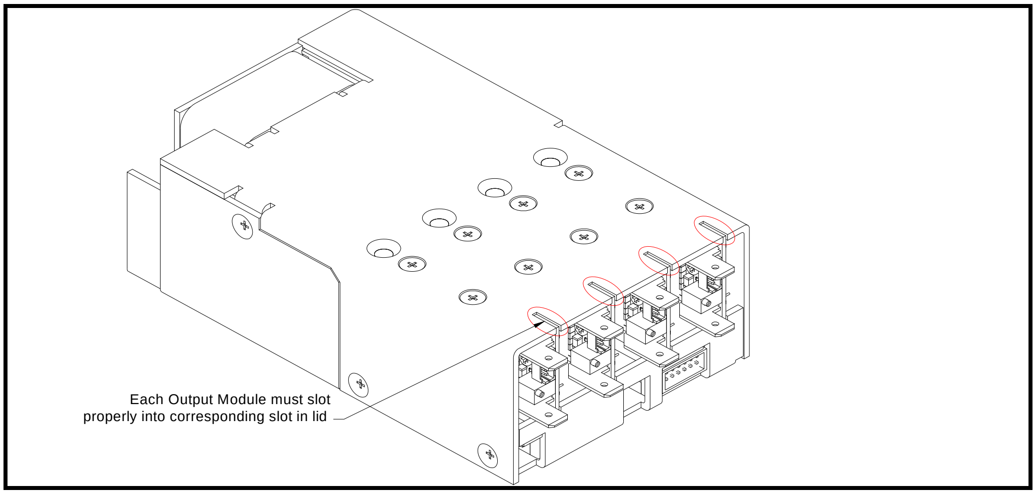
STEP3:

Once the lid is removed modules can be removed and replaced as required. The 15 pin header on the output module plugs directly into the connector on the printed circuit board. Each connector is keyed to prevent improper insertion. Insert the output module and ensure it is pushed down properly. Do not remove the plastic cover on the front-end of the unit.



STEP 4:

Once the modules are replaced and the new configuration is complete and the lid can be closed again. A blanking plate must always be used whenever a slot does not contain an output module. Attach blanking plates to the lid before closing it. Ensure the plastic cover is in place before closing the lid again. When closing the lid ensure that each output module slots properly into its corresponding slot in the lid. Insert all the screws and tighten to 1NM. Do not over tighten.



WARNING!
Do not apply power to the power supply before replacing the lid and securing all the screws.

STEP 5:

Reconnect the power cable and apply power to ensure all the output modules are working by checking that the LED light on each output module comes on. Always check the output voltage of each module to ensure it is adjusted to your requirements. Remove power and attach all other cables. The unit is now ready for use.

Safety

The NEVO unit has been designed to comply with the Low Voltage Directive 73/23/EEC (LVD) and is CE marked to show its compliance.

When correctly installed (according to the installation manual) in a limited access environment the NEVO+600S complies with the requirements of UL60950-1, EN60950-1, IEC60950-1, CSA22.2 no. 60950-1 and the NEVO+600M complies with the requirements of UL60601-1, EN60601-1, EN61010-1, IEC60601-1, IEC61010-1, CSA22.2 no 601-1.

The power supply should not be operated close to combustible materials or atmosphere.

Care should be taken to ensure liquid or metal shavings do not enter the power supply as this can cause a fire hazard.

The power supply does not contain any user serviceable parts and should be returned to Vox Power for repair.

Approval limitations (NORTH AMERICA)

When this product is used with 180VAC–253VAC mains where no neutral is present, connect the two live wires to L (Live) and N (Neutral) on the input connector.

WARNING!

Seriesed modules with combined voltages exceeding 60 volts are not considered SELV. Paralleled and/or seriesed modules with combined energy ratings greater than 240 VA may cause energy hazards. The equipments manufacturer must provide additional and adequate protection to service and technical personnel.

Always remove the power before handling the unit. During operation the external surface of the unit can become hot. Leave to stand for 10 minutes to allow the unit to cool down before handling the unit.

Dangerous voltages are present within the power supply. Covers may only be removed by qualified personnel when the power supply has been disconnected from the mains supply voltage for more than 3 minutes. Covers must be replaced and all screws secured properly before reconnecting to the mains voltage.

Parameter	Details	Min	Max	Units
Isolation voltage	Input to Output		4000	Vac
	Input to Chassis		1500	Vac
	Output to Chassis		250	Vdc
	Output to Output		250	Vdc
Isolation clearance	Primary to Secondary (Reinforced)	7		mm
	Primary to Chassis (Basic)	2.5		mm
Isolation creepage	Primary to Secondary (Reinforced)	12		mm
	Primary to Chassis (Basic)	4		mm
Leakage current	Medical: 265 Vac, 63 Hz, 25°C		300	µA
	Standard: 265 Vac, 63Hz, 25°C		1500	
Agency Approvals	$_{C}UR_{US}$, Demko, CB Certificate			
Standards	IEC/EN60950-1; UL60950-1/CSAC22.2No.60950-1-03; IEC/EN60601-1; UL60601-1; CE Mark: LVD 73/23/EEC.			
Agency File Numbers	UL : E316486			

EMC compliance

To support compliance of the final system design with the EMC directive 89/336/EEC, the NEVO PSU has been designed and tested to the following standards.

Parameter	Standard	Level
Emissions		
Radiated electric field	EN55011, EN55022, FCC	B
Conducted emissions	EN55011, EN55022, FCC	B
Harmonic distorsion	EN61000-3-2	Compliant
Flicker and fluctuation	EN61000-3-3	Compliant
Immunity		
Electrostatic discharge	EN61000-4-2 (15 kV air, 8 kV contact)	4
Radiated RFI	EN61000-4-3 (10 V/m)	3
Fast transient burst	EN61000-4-4 (4 kV)	4
Input line surges	EN61000-4-5 (1 kV L-N, 2 kV L-E)	3
Conducted RFI	EN61000-4-6 (10 V)	4
Power freq. Magnetic field	EN61000-4-8 (10 A/m)	3
Voltage dips	EN61000-4-11 (EN55024)	Compliant

For radiated and conducted emissions, compliance of the final system relies on proper installation of the PSU component. The installation guidelines detailed below should be followed.

Installation guidelines for EMC

NEVO units should be mounted within a metal enclosure using the mounting fixtures provided. If the application enclosure is not metal then a metal ground plate should be used to mount both the power supply and the load.

Decoupling the loads to the chassis or ground plate with suitably rated 100nF capacitors can assist in reducing emissions.

Both input and output cables should be fixed as close as possible to the ground plate or metal enclosure. Also, input and output cables should be separated as much as possible.

Output power and sense cables should be twisted pairs and routed parallel to each other. Do not twist sense and power cables together.

All cables lengths and loop areas should be minimised.

Where cables must enter or exit the enclosure, good high frequency 100nF decoupling capacitors of sufficient voltage rating should be connected to the cables as close to the entry/exit point as possible.

For further details or assistance contact Vox Power.

Reliability

The Nevo series has undergone extensive testing, including HALT and Environmental testing. Reliability data is collected on an ongoing basis. Please contact Vox Power or your distributor for the most up to date reliability data.